SYNOPSIS

The measurement and control instrumentation is a vital part of any process industry or in any other industry or research work. Accurate measurement of a variable is needed in order to analyse any event or process, and accurate control of different variables ensures the better quality of product at desired level with all safety aspects of operation. Thus net production cost of a plant depends on the efficient operation of measurement and control instrumentation. Most of the different measurement and control instrumentation systems available in the national and international market are either very costly or are the proprietary matters of the manufacturers, which may sometimes hinder the progress of the process industry. So, in the present project, attempts have been made to develop and study some non-conventional, low cost techniques of measurement and control of instrumentation systems for very important process variables of a process plant like level and flow. Attempts have been made to modify the existing bridge measurement networks, by minimizing its stray capacitance error. Another attempt has been made to design an accurate transducer type high DC busbar current measuring unit. Attempts have also been made to design and fabricate low cost PID controller and control components. Lastly, a work on the accurate measurement of polarisation impedance of a bio-electrode has been developed.

The theory of operation, design, development, fabrication and experimental study of each of the above measurement and control instrumentation techniques are described in the present thesis report. Since each work is different from an other works in some way or the other, critical discussions of the results of each work has been given in project report separately in each Chapter.

The whole project work is described in the present thesis report in twelve Chapters. In Chapter-I, the review of the works on the measurement and control instrumentation techniques of the important process parameters has been presented. Review of some works on bridge network measurement, high DC current measurement, controller and final control elements and polarisation impedance measurement has also been described.
In Chapter-II through Chapter-XI, some non-conventional techniques of measurement and control instrumentation have been proposed. Each technique has been utilised to design, develop and fabricate a non-conventional transducer or control component. Ten types of these techniques have been described in these chapters. Each Chapter deals with a separate technique and so each of them includes four major sections, namely, Introduction, Method of approach, Experimental results and Discussions about the respective techniques and the developed instruments. In the section “Introduction”, the aim of the proposed technique has been described along with a brief review of the classical and modern techniques with the proposed technique. In the section “Method of approach”, the theory and analysis of the proposed technique as well as the design of the transducer, signal conditioner and display units have been described. A mathematical characteristic equation of the proposed transducer or control component has been described in this section. In the section “Experimental results”, the results of the experimental study of the proposed transducer or control component have been reported in tabular and graphical forms. The performance of the proposed transducer or control component has been analysed with respect to the experimental data in the 'Discussions' section.

In Chapter-II, a modified AC bridge network has been described to measure the capacitance of any capacitive transducer more accurately than the conventional bridge network. Study of a modified Schering bridge network for the measurement of dielectric parameters of a material has been described in Chapter-III, whereas the Chapter-IV describes a novel non-contact capacitance type level transducer in a metallic and non-metallic storage tank for a conducting liquid. Application of the non-contact capacitance type transducer in a PC based level control system of a conducting liquid has been described in Chapter-V. Two types of flow measurement techniques have been described in Chapter-VI and Chapter-VII: a modified inductive pick-up type technique of measurement in a vortex flow meter has been studied and is reported in Chapter-VI,
whereas in Chapter-VII, design of a novel bridge type flowmeter for a conducting liquid has been described.

Development of a novel DC busbar current measurement technique by using transductor-based network has been presented in Chapter-VIII. The design of a low cost PID controller combined with inverse derivative control action and study of its application in a voltage control system of a DC generator has been described in Chapter-IX. The design and development of a PC-based position control system of a motorized valve has been presented in chapter-X, whereas Chapter-XI describes the study of the effect of excitation frequency on electrode polarization impedance of a bio-electrode.

Finally, a conclusive report of the whole thesis work has been presented in Chapter-XII of the report. As mentioned earlier, each part of the whole work is somehow or other different from the others, and, as such, the discussions on the performance characteristic on each part have been given in the respective chapter. So, in this conclusive report, an overall achievement of the whole project has been described along with the future scope of work. It may be mentioned here that although a huge volume of work was involved in the study, attempts have been made to perform each part of the work with the highest possible accuracy within the limits of the available infrastructure facilities. Some parts of the work, which could not be performed under the present project, may be taken up in future as described in the report.